

What is claimed is:

1. A display device of the active matrix drive type comprising a display panel having a plurality of pixels arranged in the form of a matrix, each of the pixels of the
5 display panel having a display element luminescent when supplied with electric power, and a control circuit for controlling the luminescence period of the display element within 1 frame period in accordance with data voltage to be supplied from outside, the display device being characterized
10 in that the control circuit of each pixel of the display panel comprises a first control element for starting to energize the display element and a second control element for deenergizing the display element.

2. A display device of the active matrix drive type
15 according to claim 1 wherein a voltage gradually increasing or gradually decreasing during at least a portion of 1 frame period is applied to a control terminal of each of the first control element and the second control element, whereby the operation of each control element is controlled.

20 3. A display device of the active matrix drive type comprising a display panel having a plurality of pixels arranged in the form of a matrix, and a scanning driver and a data driver which are connected to the display panel,
the display device being characterized in that each of the

pixels of the display panel comprises a display element luminescent when supplied with current or voltage, a write element to be brought into conduction when impressed with scanning voltage from the scanning driver, voltage holding

5 means to be impressed with data voltage from the data driver by the conduction of the write element for holding the data voltage, a drive element for energizing or deenergizing the display element in response to the input of an on/off control signal, an on-control element for turning on the drive element, 10 an off-control element for turning off the drive element, and control means for controlling the timing of the on-operation of the on-control element or the off-operation of the off-control element in accordance with the output voltage of the voltage holding means.

15 4. A display device of the active matrix drive type comprising a display panel having a plurality of pixels arranged in the form of a matrix, and a scanning driver and a data driver which are connected to the display panel, the display device being characterized in that each of the 20 pixels of the display panel comprises a display element luminescent when supplied with current or voltage, a write element to be brought into conduction when impressed with scanning voltage from the scanning driver, voltage holding means to be impressed with data voltage from the data driver

by the conduction of the write element for holding the data voltage, a drive element for energizing or deenergizing the display element in response to the input of an on/off control signal and an off-control element for turning off the drive element, the pixels being divided into pixel groups each comprising pixels adjacent to one another and each having an on-control element for turning on the drive element of each of the pixels of the group, and control means for controlling the timing of the off-operation of the off-control element in accordance with the output voltage of the voltage holding means of each pixel.

5. A display device of the active matrix drive type comprising a display panel having a plurality of pixels arranged in the form of a matrix, and a scanning driver and a data driver which are connected to the display panel, the display device being characterized in that each of the pixels of the display panel comprises a display element luminescent when supplied with current or voltage, a write element to be brought into conduction when impressed with scanning voltage from the scanning driver, voltage holding means to be impressed with data voltage from the data driver by the conduction of the write element for holding the data voltage, a drive element for energizing or deenergizing the display element in response to the input of an on/off control

signal and an on-control element for turning on the drive element, the pixels being divided into pixel groups each comprising pixels adjacent to one another and each having an off-control element for turning off the drive element of each 5 of the pixels of the group, and control means for controlling the timing of the on-operation of the on-control element in accordance with the output voltage of the voltage holding means of each pixel.

6. A display device of the active matrix drive type
10 comprising a display panel having a plurality of pixels arranged in the form of a matrix, and a scanning driver and a data driver which are connected to the display panel, the display device being characterized in that each of the pixels of the display panel comprises:
15 a display element luminescent when supplied with current or voltage,
a write element to be brought into conduction when impressed with scanning voltage from the scanning driver,
voltage holding means to be impressed with data voltage from
20 the data driver by the conduction of the write element for holding the data voltage,
a drive element for energizing or deenergizing the display element in response to the input of an on/off control signal,
and

pulse-width modulation control means for on/off-controlling the drive element by pulse-width-modulating the output voltage of the voltage holding means with ramp voltage having a predetermined rate of variation, the pulse-width modulation control means comprising an on-control element for turning on the drive element, and an off-control element for turning off the drive element.

5 7. A display device of the active matrix drive type according to claim 6 wherein the on-control element operates when impressed with a voltage in accordance with the ramp voltage to turn on the drive element, and the off-control element operates when impressed with a voltage in accordance with the sum of the data voltage and the ramp voltage to turn off the drive element.

10 15 8. A display device of the active matrix drive type according to claim 6 wherein the on-control element operates when impressed with a voltage in accordance with the value of sum of the data voltage and the ramp voltage to turn on the drive element, and the off-control element operates when impressed with a voltage in accordance with the value of the ramp voltage to turn off the drive element.

20 9. A display device of the active matrix drive type according to claim 3 wherein a signal line connecting a power source of high potential for supplying the current to the

display element to a power source of a low potential serving as an operation reference for the on-control element and the off-control element has an element provided thereon for blocking the current flowing from the power source of high 5 potential to the power source of low potential.

10. A display device of the active matrix drive type according to claim 3 wherein each of the pixels of the display panel comprises a current program circuit for programming the current to be passed through the display element.

10 11. A display device of the active matrix drive type according to claim 1 wherein the first control element is provided on and connected in series with a power supply line extending from a power source for supplying the electric power to the display element, is turned on when starting to energize 15 the display element and starts to energize the display element, and the second control element is turned on when deenergizing the display element and turns off the first control element to thereby deenergize the display element.

12. A display device of the active matrix drive type 20 according to claim 11 wherein the control circuit of each pixel of the display panel has a write element to be brought into conduction when impressed with scanning voltage, voltage holding means to be impressed with data voltage by the conduction of the write element for holding the data voltage,

and pulse-width modulation control means for on/off-controlling the first control element and the second control element by pulse-width-modulating the output voltage of the voltage holding means with ramp voltage having a predetermined rate of variation.

13. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each pixel of the display panel has a write transistor to be brought into conduction when impressed with scanning voltage and a capacitor to be impressed with data voltage by the conduction of the write transistor for holding the data voltage, the first control element comprising a first transistor provided on and connected in series with the power supply line and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage of the power source exceeding a predetermined threshold value, the second control element comprising a second transistor to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the power source voltage exceeding a predetermined threshold value to bring the first transistor out of conduction, a voltage in accordance with the sum of ramp voltage having a predetermined rate of variation and the output voltage of the capacitor is applied to the gate of the

first transistor, and the ramp voltage is applied to the gate of the second transistor.

14. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each 5 pixel of the display panel has a write transistor to be brought into conduction when impressed with scanning voltage and a capacitor to be impressed with data voltage by the conduction of the write transistor for holding the data voltage, the first control element comprising a first 10 transistor provided on and connected in series with the power supply line and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage of the power source or the voltage at one terminal of the display element exceeding a predetermined 15 threshold value, the second control element comprising a second transistor to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the power source voltage or the voltage at said one terminal of the display element exceeding a predetermined 20 threshold value to bring the first transistor out of conduction, a voltage in accordance with the sum of a first ramp voltage having a predetermined rate of variation and the output voltage of the capacitor is applied to the gate of the first transistor, and a second ramp voltage having a

predetermined rate of variation is applied to the gate of the second transistor.

15. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each 5 pixel of the display panel has a write transistor to be brought into conduction when impressed with scanning voltage and a capacitor to be impressed with data voltage by the conduction of the write transistor for holding the data voltage, the first control element comprising a first 10 transistor provided on and connected in series with the power supply line and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage at one terminal of the display element exceeding a predetermined threshold value, the second control 15 element comprising a second transistor to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage at said one terminal of the display element exceeding a predetermined threshold value to bring the first transistor out of conduction, a 20 voltage in accordance with the sum of ramp voltage having a predetermined rate of variation and the output voltage of the capacitor is applied to the gate of the first transistor, and the ramp voltage is applied to the gate of the second transistor.

16. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each pixel of the display panel has a write transistor to be brought into conduction when impressed with scanning voltage 5 and a capacitor to be impressed with data voltage by the conduction of the write transistor for holding the data voltage, the first control element comprising a first transistor provided on and connected in series with the power supply line and to be brought into conduction upon the 10 difference between the voltage to be applied to a gate thereof and the voltage at one terminal of the display element exceeding a predetermined threshold value, the second control element comprising a second transistor to be brought into conduction upon the difference between the voltage to be 15 applied to a gate thereof and a predetermined constant voltage exceeding a predetermined threshold value to bring the first transistor out of conduction, a voltage in accordance with the sum of ramp voltage having a predetermined rate of variation and the output voltage of the capacitor is applied to the gate 20 of the first transistor, and the ramp voltage is applied to the gate of the second transistor.

17. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each pixel of the display panel has a first signal line for

applying scanning voltage in the first half of 1 frame period and applying a first ramp voltage in the second half of 1 frame period, and a second signal line for applying data voltage in the first half of 1 frame period and applying a 5 second ramp voltage in the second half of 1 frame period, the first control element comprising a first transistor provided on and connected in series with the power supply line and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage of the 10 power source exceeding a predetermined threshold value, the second control element comprising a second transistor to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and a predetermined constant voltage exceeding a predetermined threshold value to 15 bring the first transistor out of conduction, the second signal line being connected to the gate of the first transistor via a capacitor, the first signal line being connected to the gate of the second transistor.

18. A display device of the active matrix drive type 20 according to claim 11 wherein the control circuit of each pixel of the display panel has a first signal line for applying scanning voltage in the first half of 1 frame period and applying a first ramp voltage in the second half of 1 frame period, and a second signal line for applying data

voltage in the first half of 1 frame period and applying a second ramp voltage in the second half of 1 frame period, the first control element comprising a first transistor provided on and connected in series with the power supply line and to 5 be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage at one terminal of the display element exceeding a predetermined threshold value, the second control element comprising a second transistor to be brought into conduction upon the 10 difference between the voltage to be applied to a gate thereof and a predetermined constant voltage exceeding a predetermined threshold value to bring the first transistor out of conduction, the second signal line being connected to the gate of the first transistor via a capacitor, the first signal line 15 being connected to the gate of the second transistor.

19. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each pixel of the display panel has a write transistor to be brought into conduction when impressed with scanning voltage, 20 a first capacitor to be impressed with data voltage by the conduction of the write transistor for holding the data voltage, a first transistor serving as the first control element and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the

voltage of the power source exceeding a predetermined threshold value, a second transistor serving as the second control element and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the power source voltage exceeding a predetermined threshold value to bring the first transistor out of conduction, and a third transistor to be brought into conduction when impressed with the scanning voltage to apply the power source voltage to the gate of the first transistor,

5 a voltage in accordance with ramp voltage having a predetermined rate of variation is applied to the gate of the first transistor, and a voltage in accordance with the sum of the ramp voltage and the output voltage of the first capacitor is applied to the gate of the second transistor, the gate of

10 the first transistor being connected via a second capacitor to a signal line for applying the ramp voltage thereto.

15

20. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each pixel of the display panel has luminescence period adjusting means for adjusting the luminescence period of the display element by controlling the time to turn on the first control element in accordance with the voltage at one of terminals of the display element at the time when the luminescence is started or the time to turn on the second control element.

21. A display device of the active matrix drive type according to claim 20 wherein the luminescence period adjusting means lengthens the luminescence period of the display element when the voltage across the terminals of the 5 display element increases at the time when the luminescence is started, and shortens the luminescence period of the display element when the voltage across the terminals diminishes.

22. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each 10 pixel of the display panel has a write transistor to be brought into conduction when impressed with scanning voltage to pass data voltage therethrough, a first transistor serving as the first control element and to be brought into conduction upon the difference between the voltage to be applied to a 15 gate thereof and the voltage at one terminal of the display element exceeding a predetermined threshold value, a second transistor serving as the second control element and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage at 20 said one terminal of the display element exceeding a predetermined threshold value to bring the first transistor out of conduction, a capacitor interposed between the write transistor and the first transistor, and voltage control means for preventing the voltage at a terminal of the capacitor

positioned closer to the first transistor from dropping below a predetermined potential, a voltage in accordance with the difference between a first ramp voltage and the data voltage is applied to the gate of the first transistor, and a second 5 ramp voltage is applied to the gate of the second transistor.

23. A display device of the active matrix drive type according to claim 22 wherein the voltage control means comprises a third transistor to be brought into conduction when impressed with reset voltage to connect the terminal of 10 the capacitor positioned closer to the first transistor to a power source having a voltage between the voltage of the power source to be applied to said one terminal of the display element and the luminescence starting voltage of the display element.

15 24. A display device of the active matrix drive type according to claim 22 wherein the voltage control means comprises a diode connected to the terminal of the capacitor positioned closer to the first transistor.

20 25. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each pixel of the display panel has a write transistor to be brought into conduction when impressed with scanning voltage to pass data voltage therethrough, a first transistor serving as the first control element and to be brought into conduction.

upon the difference between the voltage to be applied to a gate thereof and the voltage at one terminal of the display element exceeding a predetermined threshold value, a second transistor serving as the second control element and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage at said one terminal of the display element exceeding a predetermined threshold value to bring the first transistor out of conduction, and a capacitor interposed between the write transistor and the first transistor, a voltage in accordance with the difference between a first ramp voltage and the data voltage is applied to the gate of the first transistor, and a second ramp voltage is applied to the gate of the second transistor, the display element having a greater capacitance value than the capacitor.

26. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each pixel of the display panel has a first transistor serving as the first control element and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage at one terminal of the display element exceeding a predetermined threshold value, a second transistor serving as the second control element and to be brought into conduction upon the difference between the

voltage to be applied to a gate thereof and the voltage at said one terminal of the display element exceeding a predetermined threshold value to bring the first transistor out of conduction, a capacitor having one terminal connected 5 to a data voltage supply line and the other terminal connected to the second transistor, a third transistor to be brought into conduction only during the luminescence period within 1 frame to supply the voltage of the power source to the first transistor, and a fourth transistor to be brought into 10 conduction when impressed with a reset signal to connect said other terminal of the capacitor to the power source, a voltage in accordance with the difference between a first ramp voltage and data voltage is applied to the gate of the first transistor, and a second ramp voltage is applied to the gate 15 of the second transistor.

27. A display device of the active matrix drive type according to claim 11 wherein the control circuit of each pixel of the display panel has a write transistor to be brought into conduction when impressed with scanning voltage 20 to pass data voltage therethrough, a first transistor serving as the first control element and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage of the power source exceeding a predetermined threshold value, a second transistor serving as

the second control element and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the power source voltage exceeding a predetermined threshold value to bring the first transistor 5 out of conduction, a capacitor having one end connected to an output end of the write transistor, a third transistor to be brought into conduction when impressed with the scanning voltage to connect the other end of the capacitor to one end of the display element, and a fourth transistor to be brought 10 into conduction during the luminescence period to apply a first ramp voltage to said other end of the capacitor, said one end of the capacitor being connected to the gate of the first transistor, a line for supplying a second ramp voltage being connected to the gate of the second transistor.

15 28. A display device of the active matrix drive type comprising a display panel having a plurality of pixels arranged in the form of a matrix, each of the pixels of the display panel having a display element luminescent when supplied with electric power, and a control circuit for 20 controlling the luminescence period of the display element within 1 frame period in accordance with data voltage to be supplied from outside,

the display device being characterized in that the control circuit of each pixel of the display panel has a write

transistor to be brought into conduction when impressed with scanning voltage, a capacitor to be impressed with data voltage by the conduction of the write transistor for holding the data voltage, and a drive transistor provided on and

5 connected in series with a power supply line for supplying the electric power to the display element and to be brought into conduction upon the difference between the voltage to be applied to a gate thereof and the voltage at one terminal of the display element exceeding a predetermined threshold value,

10 and that a voltage in accordance with the sum of ramp voltage having a predetermined rate of variation and the output voltage of the capacitor is applied to the gate of the drive transistor.